



LETTERS

edited by Jennifer Sills

Ensuring Food Security

IN A RECENT PERSPECTIVE, "FOOD SECURITY UNDER CLIMATE CHANGE" (1 February, p. 580), M. E. Brown and C. C. Funk conclude that improved seed, fertilizer, land use, and governance lead to food security. I find these claims highly questionable. The green revolution model (monocultures of improved crops supported through high levels of agrochemical and other inputs) has done much to increase agricultural productivity. It does little, if anything, to increase food security.

Farmers in developed countries raise and sell crops but buy their food in supermarkets. Despite improved seeds and fertilizers, crops sometimes fail. When this happens, Western farmers receive government or other insurance payments. This scenario does not always apply in less developed regions or to subsistence farmers.

Across the wide scope of agriculture, there are plenty of ecologically sound, food-ensuring mechanisms. At the farm level, land modifications, climatically stable agroecosystems, plot landscape positioning, alternative crops or varieties, in-soil vegetative material, and well-placed biodiversity can all play a role in countering unfavorable climatic events.

Organized traditional societies avoid recurrent periods of starvation through multiple and overlapping mechanisms. For example, the Incas used crop varieties, communal irrigation, stone terraces, and plot scattering, along with community food storehouses, to lessen or mitigate famines.

Less organized farmers often rely upon a single mechanism. In wetter regions of West Africa, farmers plant rainfall-demanding rice along with drought-resistant cassava. Early European and traditional African societies placed a greater reliance upon climatically resilient tree crops. In early Europe, the acorn was the bailout crop (1). In Africa, there are a number of fruiting tree species that yield even when staple crops are lost (2).

Another advantage of alternative agricultural models—always in place, always functioning—is that they do not require monitoring or prediction.

PAUL WOJTKOWSKI

65 Dexter Avenue, Pittsfield, MA 01201, USA.

References

1. D. A. Bainbridge, *Ambio* **14**, 148 (1985).
2. F. A. M. Harris, S. Mohammed, *Ambio* **32**, 24 (2003).

Response

WOJTKOWSKI SEEMS TO ASSERT THAT MONITORING and prediction of variations in agricultural productivity are not only unnecessary, but actually a waste of resources for ensuring food security. He also seems to assert that we propose a one-size-fits-all, Western, agribusiness solution. We disagree with both of these assertions. Our suggestions regarding how to ensure adequate food availability in regions chronically food-insecure certainly include many of the food-ensuring approaches mentioned by Wojtkowski, such as land modifications and plot landscape positioning. Our piece also focused on other issues that affect the ability of the poorest and most vulnerable to access food, such as governance and technological transformation. The sources of food insecurity are complex and will require complex solutions (1).

While there is a role for conventional seed, fertilizer, and other technology, many natural resource management techniques mentioned by Wojtkowski have been successfully implemented in the Sahel and can lead to incremental gains that help close the food security gap. Farmers in Africa have always had diverse agroecosystems, and examples abound of those who have increased their agricultural diversity and productivity. An excellent example is Niger, where tree planting and conservation have transformed highly degraded landscapes into productive agroecosystems. Farmers are able to produce more food on less land, more reliably (2, 3). Nevertheless, Niger faces chronic and mounting food-production challenges that will be difficult to meet through improved landscape ecology alone. In Niger, 20 years ago, fertility rates were seven children per

woman. Today, fertility rates are 7.2 per woman, and Niger has cultivated 91% of its potentially cultivatable land. Under current population and agricultural expansion rates, Niger will run out of new land to cultivate by 2015 (4).

Issues of food security are compounded by the impacts of poor governance on food access and utilization. Governance includes the education of women and children, provision of clean water and health care, and a stable functioning market system. Again, Niger is a good example of the complexity of the food security problem (4). There are still incredibly high levels of malnutrition in the country, particularly among children. In the 2004–2005 crisis, chronic malnutrition caused by poor child-feeding habits and an insufficiently diverse diet was exacerbated by declines in food production outside of the



Incan terraces. Societies throughout history have used a variety of methods to ensure food security. Stone terraces built by the Incas are one example.

country and high food prices. These changes in food availability and access caused massive increases in enrollments in child-feeding programs and a large increase in the need for humanitarian assistance.

Ensuring food security for all in the face of climate-caused reductions will require adequate food production through improved seed and fertilizer; better land use policies and good governance; as well as appropriate interventions, safety nets, and investments during crises. Africa's culture, landscape, and challenges are complex, and complex solutions integrating responses from the social, political, economic, and biophysical domains will be required.

MOLLY E. BROWN,¹ CHRISTOPHER C. FUNK,²
JAMES VERDIN,³ GARY EILERTS⁴

¹SSAI/NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA. ²Department of Geography, University of California, Santa Barbara, CA 93106, USA. ³U.S. Geological Survey, Sioux Falls, SD 57198, USA. ⁴U.S. Agency for International Development, Washington, DC 20523, USA.

References

1. OXFAM, *Causing Hunger: An Overview of the Food Crisis in Africa*, OXFAM briefing paper, July 2006; www.oxfam.org/en/policy/briefingpapers/bp91_africa_food_crisis.
2. R. Harris, "Niger's trees may be insurance against drought," National Public Radio, All Things Considered, July 2007; www.npr.org/templates/story/story.php?storyId=11608960.
3. The World Bank, "Agriculture for development" (World Development Report, 2008); <http://go.worldbank.org/ZJJAOSUFU0>.
4. M. G. Wentling, "Niger—Annual Food Security Report: Current Situation and Future Prospects" (USAID/WA Country Program Manager for Niger American Embassy, Niamey, Niger, 2008).

Coarse-Resolution Models Only Partly Cloudy

IN THEIR REPORT, "A MADDEN-JULIAN Oscillation event realistically simulated by a global cloud-resolving model" (14 December 2007, p. 1763), H. Miura *et al.* promote the impression that coarse-resolution climate models cannot simulate the Madden-Julian Oscillation (MJO). We would like to point out that some coarse-resolution climate models, using conventional parameterizations of convection and clouds, can represent the boreal winter and summer MJO with fidelity (1–9).

In several studies, one coarse-resolution atmospheric model validated the MJO in terms of convection, eddy stream function, and surface evaporation, and it was hypothesized that lack of air-sea interaction contributed to shortcomings in the MJO simulation (1). This hypothesis was later borne out, resulting in a more realistic MJO simulation (2). Subsequently, the model was used for idealized predictability studies that demonstrated

the potential for the MJO to be forecast with lead times of 15 to 30 days (3). Using a different set of models, for which more complete model diagnostics were available, important aspects of the MJO were realistically represented, including the relationships between convection and low-level moisture convergence, surface fluxes, the vertical structure of winds and divergence, and air-sea interactions (4). None of these relationships, including the spontaneous generation of MJOs, have been adequately demonstrated in Miura *et al.* to justify their claim of a realistic MJO or their inference that high-resolution models may be necessary to represent the MJO.

Other coarse-resolution simulations capture the northward propagating component of boreal summer intraseasonal variability (5–7). During both summer and winter, a realistic representation of the time-mean climate state is required to produce a realistic MJO (4, 8, 9). These works provide evidence that coarse-resolution climate models have been successful in understanding mechanisms involved in the propagation of the

MJO, and for exploring important applications of MJO variability and predictability.

KENNETH R. SPERBER,^{1*} JULIA M. SLINGO,²
DUANE E. WALISER,³ PETER M. INNESS²

¹Lawrence Livermore National Laboratory, Program for Climate Model Diagnosis and Intercomparison, Post Office Box 808, L-103, Livermore, CA 94551, USA. ²National Center for Atmospheric Science and Walker Institute, University of Reading, Earley Gate, Reading RG6 6BB, UK. ³Jet Propulsion Laboratory, MS 183-505, California Institute of Technology, Pasadena, CA 91109, USA.

*To whom correspondence should be addressed. E-mail: sperber1@llnl.gov

References

1. K. R. Sperber, J. M. Slingo, P. M. Inness, K.-M. Lau, *Clim. Dyn.* **13**, 769 (1997).
2. D. E. Waliser, K.-M. Lau, J.-H. Kim, *J. Atmos. Sci.* **56**, 333 (1999).
3. D. E. Waliser, K.-M. Lau, W. Stern, C. Jones, *Bull. Am. Meteorol. Soc.* **84**, 33 (2003).
4. K. R. Sperber, S. Gualdi, S. Legutke, V. Gayler, *Clim. Dyn.* **25**, 117 (2005).
5. X. Fu, B. Wang, *J. Clim.* **17**, 1263 (2004).
6. K. Rajendran, A. Kitoh, *J. Clim.* **19**, 366 (2006).
7. K. R. Sperber, H. Annamalai, *Clim. Dyn.*, 10.1007/s00382-008-0367-9 (2008).
8. P. M. Inness, J. M. Slingo, *J. Clim.* **16**, 345 (2003).
9. P. M. Inness, J. M. Slingo, E. Guilyardi, J. Cole, *J. Clim.* **16**, 365 (2003).

CORRECTIONS AND CLARIFICATIONS

Newsmakers: "Thermometer kings" (4 April, p. 29). Richard Porter's thermometer collection did not include an earring thermometer from a 1650 whaling ship.

News of the Week: "China's modern medical minister" by R. Stone (28 March, p. 1748). Chinese minister Wan Gang's name was misspelled.

Random Samples: "Homeward buzz" (March 14, p. 1465). The article referred to a "colony of 750,000" bees. The collection is actually 56 colonies of 14,000 bees each. Each colony has its own queen.

Reports: "Asphericity in supernova explosions from late-time spectroscopy" by K. Maeda *et al.* (29 February, p. 1220). In author affiliation 16, the name of the institution should have been Institute of Space and Astronautical Science (not Astronomical Science). In ref. 8, the order of author names was incorrect. The reference should read as follows: 8. R. Buras, H.-Th. Janka, M. Rammpp, K. Kifonidis, *Astron. Astrophys.* **457**, 281 (2006).

Reports: "Nonadiabatic interactions in the Cl + H₂ reaction probed by CH₂⁺ and ClD₂⁺ photoelectron imaging" by E. Garand *et al.* (4 January, p. 72). This research was supported by Air Force Office of Scientific Research grant F49620 03 1 0085 (D.M.N.), NSF grant CHE0413743 (M.H.A.), and Office of Naval Research grant N000140510460 (D.E.M.). E.G. thanks the Natural Science and Engineering Research Council of Canada for a postgraduate scholarship.

TECHNICAL COMMENT ABSTRACTS

COMMENT ON "Long-Lived Giant Number Fluctuations in a Swarming Granular Nematic"

I. S. Aranson, A. Snezhko, J. S. Olafsen, J. S. Urbach

Narayan *et al.* (Reports, 6 July 2007, p. 105) reported giant number fluctuations attributed to curvature-driven active currents specific for nonequilibrium nematic systems. We present data demonstrating that similar results can be found in systems of spherical particles due either to inelastic clustering or persistent density inhomogeneity, suggesting two alternative explanations for their results.

Full text at www.sciencemag.org/cgi/content/full/320/5876/612c

RESPONSE TO COMMENT ON "Long-Lived Giant Number Fluctuations in a Swarming Granular Nematic"

V. Narayan, S. Ramaswamy, N. Menon

On the basis of experiments using monolayers of spherical grains, Aranson *et al.* suggest that the giant number fluctuations we observed in active granular rods may be explained by static inhomogeneity or inelastic clustering. We refute these alternative explanations and underline the evidence that the fluctuations originate in nematic ordering.

Full text at www.sciencemag.org/cgi/content/full/320/5876/612d

Response

WE DEMONSTRATED THAT A GLOBAL CLOUD-resolving model (GCRM) can simulate the realistic evolution of a single Madden-Julian Oscillation (MJO) event, including its internal structures. We did not claim that GCRMs provide a full solution to the MJO problem or that conventional general circulation models (GCMs) cannot simulate the MJO.

The essential mechanisms of the MJO are not yet comprehensively understood, and consequently, whether GCMs and GCRMs can fully simulate the MJO remains undetermined. The MJO simulations in our Report demonstrate that a GCRM can

marginally reproduce the internal cloud systems and overall structure of a single MJO event over a period of one month (1). Finer internal structures and topographic effects were also better simulated because of the finer horizontal resolution. Contrary to the assertion of Sperber *et al.*, however, we did not claim that either GCRMs or GCMs embedding two-dimensional cloud-resolving models were the only way to produce realistic MJO simulations.

Most of the papers cited by Sperber *et al.* stated that air-sea interaction is necessary to simulate the MJO by GCMs. However, we believe that this point is still controversial (2, 3). We have studied this issue and performed a sensitivity test with a 14-km horizontal grid. The time evolution of an MJO event did not differ very much between the simulations with the observational time varying sea surface temperature (SST) and the fixed SST, though the convective activity of the MJO was weaker in the fixed SST run. A GCM embedding a two-dimensional cloud-resolving model also simulated the MJO without feedback from intraseasonal perturbations in SST (4). These results sup-

port the hypothesis that the MJO is inherently an atmospheric mode, even if it can be modified and perhaps amplified by air-sea interactions (5, 6).

HIROAKI MIURA,^{1,2*} MASAKI SATOH,^{1,3} TOMOE NASUNO,¹ AKIRA T. NODA,¹ KAZUYOSHI OOUCHI¹

¹Frontier Research Center for Global Change, Japan Agency for Marine-Earth Science and Technology, 3173-25 Showamachi, Kanazawa-ku, Yokohama, Kanagawa 236-0001, Japan. ²Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523-1371, USA. ³Center for Climate System Research, University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8568, Japan.

*To whom correspondence should be addressed. E-mail: miura@atmos.colostate.edu

References

1. D. L. Hartmann, H. H. Hendon, *Science* **318**, 1731 (2007).
2. Climate Change 2007, "The physical science basis," Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 8, Climate Models and Their Evaluation, 8.4.8 Madden-Julian Oscillation (p. 625).
3. C. Zhang, *Rev. Geophys.* **43**, RG2003 (2005).
4. M. F. Khairoutdinov, D. A. Randall, C. DeMotte, *J. Atmos. Sci.* **62**, 2136 (2005).
5. D. E. Waliser, K.-M. Lau, J.-H. Kim, *J. Atmos. Sci.* **56**, 333 (1999).
6. P. M. Inness, J. M. Slingo, *J. Clim.* **16**, 345 (2003).

Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 3 months or issues of general interest. They can be submitted through the Web (www.submit2science.org) or by regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.